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# VINEYARD PLANTING STOCK

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Cuttings or rootings of the desired fruiting variety, bench grafts, and resistant stock rootings may be used to plant a vineyard; but not always interchangeably. The choice is governed by several factors: (1) the presence or absence of phylloxera;[2] (2) the presence or absence of nematodes;[3] (3) the location of the vineyard and climatic conditions; (4) the skill of the farmer, or available labor, in field budding or grafting; and (5) availability.

## CUTTINGS

Nearly all grape varieties,[4] whether for fruiting or rootstocks, are propagated by cuttings. These are usually grown in a nursery for one year to produce rootings. The cuttings may be grafted before being planted in the nursery, to produce bench grafts. Occasionally, unrooted cuttings are planted directly in the vineyard.

For grape cuttings, sections of canes (matured current season's growth) are always used. They should be made during the dormant season from well-matured, healthy, productive vines, known to be of the desired variety. Their length is 14 to 24 inches, according to the intended use. The basal end is cut nearly straight across close below a node; the top is cut at an angle of about 45°, from 1 to 1½ inches above a node, to avoid injuring the top bud and to help orient the cuttings in handling and planting. Grape cuttings planted upside down will not grow.

The use of unrooted cuttings to plant a vineyard is not encouraged, because poor stands usually result. The practice does sometimes have advantages: if handled properly to avoid contamination, the cuttings are free from phylloxera, nematodes, and crown gall (black knot); they are slightly less susceptible to injury from drying in handling; they are cheaper in first cost and may be available when rootings or bench grafts of the desired variety are not. If a vineyard must be planted with unrooted cuttings, every precaution should be taken to secure a good stand. Only the best cuttings should be used; medium-large ones taken from the base (the part of the cane immedi-

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[2] *Dactylosphaera vitifoliae* Shimer (*Phylloxera vitifoliae* [Fitch]), a minute yellow louse that feeds on the roots and thereby destroys the vines.

[3] Mainly the root-knot or common garden nematode, *Heterodera marioni* (Cornu), a small worm (scarcely visible to the eye) that enters the roots, causing swellings or galls. In severe cases it seriously weakens and may kill the vines.

[4] A few varieties whose cuttings are difficult to root are propagated by layering; seeds are used only to produce new varieties.

ately off the old wood) are preferred. Long cuttings—18 inches for loam soils, 24 inches for sandy soils—are less apt to dry out after planting than short ones. The cuttings should be bundled promptly and kept covered with canvas or wet burlap. For storage, the bundles should be completely buried in moist, fine sand. The storage place must be well drained.

Early planting is preferred. Deep holes are advantageous, and the soil must be firmly packed around the cuttings. Very long cuttings may be bent in the bottom of the hole. After planting, only the top bud should be above the soil level; and it should be completely covered with a mound of loose soil. Then, unless heavy rains fall soon, irrigation is needed; the soil must be kept moist until the cuttings have rooted and made several inches of new top growth. If dibbles are used in the planting, the soil must be firmed carefully around the full length of the cuttings.

### ROOTINGS OF FRUITING VARIETIES

In soils not heavily infested with nematodes, and located in areas free from phylloxera, rootings of the desired fruiting variety constitute the best planting stock. In clean soils own-rooted vines are usually superior in vigor, productivity, and fruit quality to vines grafted on resistant rootstocks. Furthermore, grafting is expensive; bench grafts, or resistant-stock rootings plus the necessary field budding, cost three or four times as much as rootings of the fruiting varieties. Unless special rootstocks are needed, therefore, to combat phylloxera, or nematodes, or both, grafted vines or resistant stocks are unnecessary and should not be planted.

Southern California is still relatively free from phylloxera. Nematodes are not a serious factor there, except in limited areas where the population has been built up by growing highly susceptible crops on sandy soils. In the San Joaquin and Sacramento valleys the counties of Stanislaus, Merced, and Tehama are free from phylloxera; and Kern, Kings, and Madera have only localized areas of infestation. Except in and adjacent to the infested areas, phylloxera-resistant stocks are not needed. The farm advisor or the agricultural commissioner may be consulted for information regarding danger zones. San Joaquin County and the entire Sacramento Valley, except Tehama County, have many local areas of infestation; in the older vineyard areas phylloxera-resistant rootstocks are advised for loam and heavier soils. New lands not adjacent to other vineyards may be planted to own-rooted vines with reasonable safety. Fresno and Tulare counties have large areas of general infestation, particularly east of the city of Fresno and in the Dinuba-Cutler-Yettem area. Many other smaller danger zones occur. Although there are still large areas of uninfested land in these two counties, any grower planting vines on soils of sandy-loam or heavier texture is advised to investigate the probable danger of phylloxera. If no phylloxera is present within a half mile, he will probably get the best vineyard by using rootings of the desired fruiting variety. If phylloxera is known to be present in his soil or in an adjacent vineyard, resistant rootstocks are advised.

Sandy soils in the San Joaquin Valley and also in San Joaquin County are mostly free from phylloxera, but may be heavily infested with nematodes. Where the infestation is not heavy, own-rooted vines are advised. These vines

may be slightly or moderately affected and still do very well. Some soils are so badly infested, however, that nematode-resistant rootstocks are required. To determine what areas require resistant vines, the grower can raise a moderately susceptible annual crop on the land before planting the vineyard. Tomatoes, squash, most varieties of beans, or even cotton will serve the purpose. Where these susceptible crops grow well, own-rooted vines may be used; where failure results because of nematodes, resistant rootstocks are advised for grapes. In the Sacramento Valley, nematode-resistant stocks are seldom needed.

The entire north coast region, except parts of San Benito County, must be considered to be generally infested with phylloxera, but is generally free from nematodes. Phylloxera-resistant rootstocks are required in most areas and are advised for all new plantings in the coastal valleys and adjacent rolling lands.

To produce rootings, cuttings 12 to 16 inches long are grown in a nursery for one season. The planting and care of the nursery are briefly discussed in another section.

In preparation for planting, the top growth of the rooting is pruned to a single 2- or 3-bud spur of new wood. The roots may be shortened to 3 or 4 inches for convenience in planting. Holes, as deep as the rootings are long, are dug where the vines are to stand; the rooting is planted with the top at the level of the soil and exactly at the stake or marker; the soil is very firmly tramped around the roots and stem as the hole is filled; the planting is finished by covering the entire top to a depth of 2 or 3 inches with well-pulverized soil. Subsoiling to a depth of 18 inches in both directions, so that the stakes may be driven and the vines planted at the intersections of the cuts, will usually be repaid in cost by the saving in labor of laying out and planting the vineyard. This is particularly true in gravelly soils or where previous farming practices have resulted in a plow sole.

## BENCH GRAFTS

The easiest way to establish a vineyard on resistant rootstocks is to plant one-year-old bench grafts. These, if properly disbudded, are almost as easy to handle as rootings. The first cost is high, however; and often the variety wanted may not be available. Bench grafts are particularly useful on dry lands where the vines are apt to stop growing in late summer and where misses must be replanted in an established vineyard; under these conditions it may be difficult to secure a good stand from fall budding in the field.

Few have the skill, technical knowledge, and equipment needed to produce bench grafts successfully; the job is best done by specialized nurserymen. Growers needing bench grafts for vineyard planting are advised to contract for the needed stock with a capable nurseryman a year before planting. The following directions may aid growers who desire to produce their own bench grafts despite the difficulties involved.

The wood for the stock cuttings and scions should be carefully selected from vines of the desired variety, vigorous and well matured. The selected canes are often made up in lengths of 30 inches or more. When the grafting is done, the long pieces are cut into the desired lengths—about 11 or 12 inches for the stocks, and single-bud pieces for the scions.

The stocks are cut at the bottom immediately below the basal node, and at the top 1½ to 2 inches above a node. They are then disbudded (all buds completely removed) with a knife or small pruning shears to prevent suckering. The scions are cut with 1½ to 2 inches of internode below and ½ inch above the bud. Both stocks and scions are graded according to diameter into equivalent size grades.

Fig. 1.—The long whip graft: *A*, The sloping cuts made on the stock and scion; *B*, the tongues cut and opened out; *C*, the completed graft. (From Ext. Cir. 101.)

The grafting may be done by machines or by hand. Few growers or even nurserymen have access to grafting machines. For hand grafting the long whip is preferred (fig. 1). Stocks and scions are cut exactly alike except that the cut is at the top of the stock and at the bottom of the scion piece. The cuts must be made straight and smooth, at an angle of 15° to 25°. The lengths of cut surfaces are therefore about 2½ to 4 times the diameter of the pieces and must fit each other when placed together. The tongue is made with a slow, sliding motion of the knife, starting about one third of the distance in from the point and continuing in a straight plane downward, bisecting the

angle of the bevel cut and the grain of the wood, until the tongue is one third the length of the bevel cut. The knife is slowly withdrawn with an oblique motion to avoid breaking the tongue; and just before the blade is free of the cut the tongue is carefully bent out to open the cut. The stock and scion are now placed together with the tongues interlocking. The cut surfaces should coincide almost perfectly.

The grafts are held firmly together with raffia, string, or grafting rubber until they unite by growth of their own tissues. If rubber is used, it should not be so closely wrapped that air is excluded. Storage from the time of grafting to planting is best done in moist, fine sand. For convenience in handling, the grafts are tied in bundles of 10 each before being buried in the sand.

When soil and weather have become warm (early April), the grafts are planted in the nursery.

When dug the following winter, the grafts should be carefully sorted. Those with good unions, together with good top and root growth, may be planted in the vineyard. The weak grafts should be planted in the nursery another year, after which most of them will be good enough for field planting.

For vineyard planting the tops of the bench grafts should be pruned to a single spur of new growth 2 or 3 buds long; the roots may be shortened to 3 or 4 inches. In the vineyard the grafts should be planted so that *the unions will be at the top of the soil when the vineyard is mature.* In nonirrigated soil where flat tillage is the rule, the unions may be placed at the soil level. But in irrigated vineyards where ridges of earth are thrown up in the row (purposely or not), the graft unions must be at the top of the ridge; otherwise the scions will root, and the resistant roots may die. When planting is finished, the entire top of the graft is covered 2 to 3 inches deep with a mound of well-pulverized, moist soil.

### RESISTANT ROOTSTOCK ROOTINGS

Rootstock cuttings may be taken from any vigorous canes of the desired variety. Suckers from grafted vines in the vineyard may be used if they occur and if they are of the variety desired. These cuttings should be longer than those of the fruiting varieties for nursery planting so that when they are set in the vineyard 2 or 3 inches of the rooting may be aboveground for budding or grafting; 16 to 18 inches of length is convenient. *Before planting in the nursery, all buds except the one at the top of the cutting should be removed by cutting deeply with a knife or small pruning shears.* Such disbudding is essential to avoid suckers in the vineyard; to remove suckers is laborious and costly. Direct planting of rootstock cuttings in the vineyard is very poor practice because many of them fail to grow.

For planting in the vineyard, the rootings are pruned as described for those of the fruiting varieties.

If the disbudding operation was not done when the cuttings were planted in the nursery, the rootings must be disbudded before being placed in the vineyard. Failure to do the disbudding may result in a short-lived vineyard, one extremely expensive to maintain because of sucker growth from the rootstocks. To disbud the rootings is much more difficult and costly than to disbud

the cuttings. When the rooting is planted, its top *must be above the permanent surface of the soil* to permit budding or grafting high enough to discourage scion roots. The entire vine should be covered to a depth of 2 or 3 inches with a mound or ridge of soil; the mound or ridge should be maintained around the vines to the top of the original cutting until the budding or grafting is done. This practice will facilitate the work of budding or grafting by avoiding sunburning or drying of the upper part of the vine and will contribute much toward a successful result.

## PLANTING AND CARE OF THE NURSERY

The tract selected for the vine nursery should be one of well-drained, fertile soil, well leveled for uniform irrigation, and free from nematodes. For bench grafts, friable sandy-loam soils are preferred. Rootings are successfully

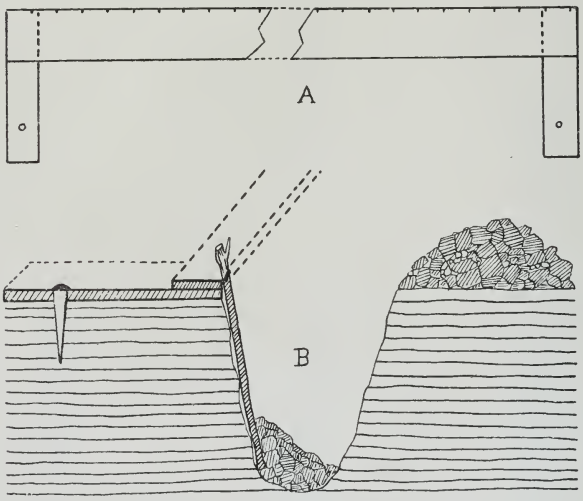


Fig. 2.—*A*, Planting board. *B*, Diagram showing use of planting board with bench grafts. (From Cir. 288).

grown on various soils ranging from sand to clay loam. Adequate irrigation is almost essential. In preparation for planting, the soil should be deeply plowed or subsoiled to a depth of 12 to 16 inches, when it has the proper degree of moisture to break up into a loose, friable condition without large clods. Further preparation should be such as to put it into good seedbed condition.

The method of planting varies with the size of the nursery, the equipment at hand, and the availability of irrigation. If water can be had at planting time, a large nursery of cuttings can be planted most economically by using a modified subsoiler to form the rows. A furrowing shovel or a pair of small lister wings may be attached to the standard of the subsoiler, about 12 or 14 inches above the shoe, to make a small furrow in which water is run to fill the subsoiler cut and soften the soil. While the water is in the furrow, the cuttings are pushed into the soft soil, leaving the top bud on each cutting 2 or 3 inches above the general level of the soil. Cuttings planted upside down will not grow. When the row is finished, the water is turned off and the row of

cuttings covered with a wide ridge of loose soil, as shown for bench grafts in figure 3. The wet soil settles firmly around the cuttings and gives them an excellent chance to grow. Planting in a dry subsoiler cut is not advised, but it is occasionally done if irrigation can follow within a few days.

Another good method of planting—preferable to that described above when irrigation water is not available at planting time—is as follows: With a turning plow, a very deep furrow (at least 10 inches) is drawn with the land side of the furrow in the position where the row is to be. Then the bottom of this furrow is loosened 3 or 4 inches deeper by going through it with a second, smaller plow, a light subsoiler, or other suitable implement. The loose soil thus formed in the bottom of the furrow is not removed. The cuttings are stuck into the loose soil so that they rest against the vertical side of the furrow. The

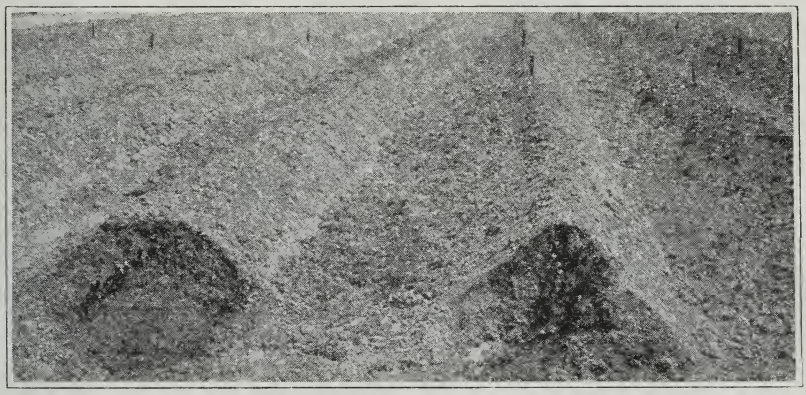

Fig. 3.—A newly planted nursery of bench grafts. The two rows in the foreground have been partially uncovered. (From Ext. Cir. 101.)

soil around the base of the cuttings is firmly packed by tramping. Then most of the soil thrown out of the furrow is turned back into it and again tramped firmly around the cuttings. The ridge of loose soil completely covering the cuttings is made with a shovel and finished with a garden rake. If the soil is in ideal condition, the land side of the furrow will stand up; and the cuttings may be planted without a planting line or board. If the soil is too loose or too dry, the land side of the furrow breaks down; and a taut line or a board (fig. 2) must be used to obtain a straight row. Irrigation should follow within a few weeks after planting unless the soil has been thoroughly wet by rain in the meantime.

In a fertile soil where the nursery can be frequently irrigated, the cuttings may be spaced as closely as 2 inches in the row, with the rows 4 feet apart. In a less fertile soil, especially one that cannot be well irrigated, wider spacing in the row will produce larger and better rootings.

Bench grafts require more careful handling, and more prompt covering to prevent drying of the unions, than do cuttings. In a small nursery the bench grafts may be planted in a trench about 10 inches deep, with one straight wall—such as is made with a turning plow—after the soil in the trench bottom has been loosened 3 or 4 inches deeper. A planting board is laid along the edge of the straight side of the trench; the grafts are placed about 3 inches

apart against the straight wall of the trench, with the unions at the top of the board (fig. 2); the trench is filled with soil firmly packed around the stocks by tramping; the planting board is moved to a new position; and then the scions are carefully covered to a depth of 2 or 3 inches with a broad ridge of fine, moist soil (fig. 3). An irrigation should follow within a day or two, but should not wet the tops of the ridges.

A large nursery of bench grafts can be more economically planted in wet furrows. Deep furrows—10 inches or more—are made with a lister in well-prepared soil. The furrow is filled with water; then the water is turned off, and the bench grafts are laid against one side of the wet furrow with the unions all just above the general soil level. They are covered immediately to

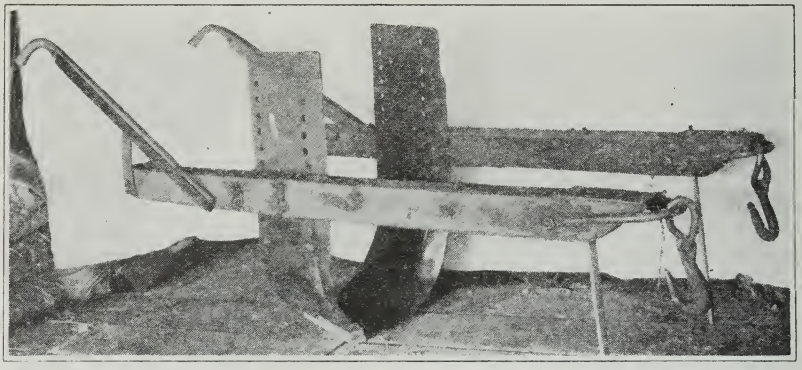

Fig. 4.—Nursery digger. (From Ext. Cir. 101.)

a depth of 2 or 3 inches by shoveling a broad ridge of fine, moist soil over the row. When planted in this manner the grafts are on a steep slant; and, in subsequent cultivation, care must be used to avoid damaging them.

When the grafts are well established and growing vigorously (late July or early August), the unions should be uncovered; scion roots and stock suckers removed; and the tying material (raffia, string, or rubber) cut if it has not already rotted. The soil need not be replaced around the grafts after these operations, but irrigation should follow immediately.

No set rules for the care of the nursery can be given except that weeds should be controlled and irrigations should be frequent enough to keep the vines growing continuously until the first of September. After that time irrigation is seldom needed; the vines will mature best if the soil becomes dry enough to cause a few leaves to drop before frost occurs.

The nursery may be dug any time after the leaves drop. In large nurseries the vines are cut with a nursery digger (fig. 4) and pulled by hand. Small nurseries may be dug by plowing a furrow away from each side of the row, after which the vines can be dug out by hand labor, the roots being cut with a shovel to a length of 2 to 6 inches. If the vines have made a large top growth, the tops may be cut back to a few inches in length, to facilitate digging. For storage the vines may be heeled in loose or in bundles of 25 each; large bundles should be avoided. They should be covered with moist soil at least as deep as in the nursery; if they will remain over a month, complete coverage is better.

### FIELD BUDDING

Resistant rootstocks must, of course, be worked to the desired fruiting variety. Fall budding is the most popular method of doing this in the vineyard and probably the best. Mature scion buds and actively growing stocks are prime requisites for success. The budding is done, therefore, as early as mature buds of the desired variety can be obtained—August in the cooler regions on nonirrigated soils, September in the warm regions on irrigated soils. Working with green buds, or on dry stocks that have stopped growing, is the usual cause of failure. The buds should be plump and taken from canes

*A* *B* *C* *D*

Fig. 5.—Steps in budding vines: *A*, The bud removed from the bud stick; *B*, notch made in the stock to receive the bud; *C*, the bud in place; *D*, finished and tied, ready to be covered with soil. (From Ext. Cir. 116.)

of light-brown bark color from which the leafstalks (petioles) break in a normal, mature manner at the layer of corky tissue (abscission layer), so that there is almost no wound. The bark over the nodes and on the tendrils opposite the buds should be uniformly brown, since green areas on these parts, even though the bark elsewhere is brown, usually indicate insufficient maturity, poor nutrition, or disease. Buds at the base of large laterals are best avoided; those at the base of small, matured laterals are not objectionable. The leaves are removed from the bud sticks as soon as the latter are cut from the vines. The bud sticks must be kept fresh in moist packing material until used. The stocks must be actively growing. Irrigation in early or mid-August, where possible, will contribute to good stock condition.

A special form of chip bud (fig. 5) is commonly used. To remove the bud from the cane, the first cut is made deep into the bud stick, beginning $\frac{3}{16}$ to $\frac{1}{4}$ inch below the bud and sloping downward at an angle of about 45°. The second cut is started $\frac{1}{2}$ to $\frac{3}{4}$ inch above the bud; and the knife travels in a nearly straight plane behind the bud to the first cut, removing a wedge-shaped piece $\frac{1}{8}$ to $\frac{3}{16}$ inch thick at the lower end (fig. 5, *A*). Some workmen reverse the order in which the cuts are made. The wood in the chip is not removed from the bud.

A notch into which the bud will fit well is made in the stock at or near the height where the soil surface will come in the mature vineyard, and preferably on the side of the vine from which most of the top growth arises. The work is facilitated by first removing the soil around the vine to a depth of 4 or 5 inches. The angle made by the two cut surfaces of the notch in the stock may be slightly more acute than the angle formed by the cut surfaces of the bud piece. This technique insures intimate contact between the lower end of the bud piece and the corresponding cut surface of the stock. The bud chip must fit well in the notch. It is then securely tied in place with budding rubber or raffia (fig. 5, *D*).

Immediately after being tied, the bud is covered with moist, well-pulverized soil; and this, in turn, is covered with 4 to 8 inches of well-pulverized soil, which may be moist or dry. If the soil is fairly moist, a covering 4 inches deep may be adequate; if dry, 8 inches is better. In very dry soil, ¼ to ½ of the tops of the vines may well be cut off at the time of budding. The bud calluses in—that is, grows fast to the stock—within 4 weeks. It usually remains dormant, however, until the following spring.

During the winter, field-budded vines need no special treatment except staking or trellising, if that work has not already been done. To avoid damaging the buds in driving the stakes, it is best to stake the vineyard before planting. The following spring, when the buds on the rootstock vines are just starting growth, the scion buds should be uncovered. The usual procedure is then as follows: Cut the rubber used for tying. Carefully examine the scion bud on each vine to ascertain that it is alive and grown fast to the stock; do not hesitate to apply considerable pressure to the bud chip, for, if the union is good, the chip can hardly be dislodged by one's fingers. If the scion bud appears well united with the stock and is beginning to grow, cut off the stock 1 or 1½ inches above the bud. Place a building-paper sleeve about 1½ or 2 inches in diameter and about 9 inches long over the end of the stock and the scion bud. To keep the sleeve from blowing away, bank 3 or 4 inches of loose soil around the lower end. As soon as the scion shoot grows up through the sleeve, tie it to the stake. Remove all stock suckers and scion roots whenever they appear. If the scion bud is not good, the vine may be whip-grafted immediately (fig. 1); or it may be pruned back to 1 or 2 buds and then rebudded next fall. Grafting is preferred in fertile, irrigated soils; rebudding on poor or unirrigated land.

Often stocks are killed by cutting them off when the scion buds are imperfect. Without considerable experience it is not easy to find all the poor unions. Rootstock rootings properly disbudded before planting usually grow only from the top or from the scion bud; hence, if the top is cut off and the scion bud fails to grow, the vine is lost. To avoid this danger, the following procedure is suggested: About the time the rootstock buds are ready to break, uncover the vines to expose the scion buds. Prune all the canes on each rootstock back to base buds. Cover the scion bud lightly (an inch) with loose soil, or place a building-paper sleeve over it. Watch the vines closely, going over the vineyard about once a week. As the scion buds start, cut off the tops of the rootstocks an inch or more above them. As the scion shoots grow, tie them carefully to the stakes as in training any other vines. Thereafter keep the

soil away from the base of the scion shoot to discourage scion roots, and take off all stock suckers that start from the rootstocks. After the lower parts of the scion shoots have hardened (May or early June), remove the rubbers. Each time, in going over the vineyard, remove all shoots from the stocks on which the scion buds have not started. Any scion buds that have not started by the middle of May are probably defective. Uncover them, cut the rubbers, and make an examination. Thereafter, allow the shoots to grow on all stocks that have defective scion buds. Rebud these next fall.

Other methods of grafting[5] may be employed if the workmen are familiar with them.

## ROOTSTOCK VARIETIES

Most rootstock varieties are hybrids that have been artificially produced from crosses involving two or more grape species. A very few are selections from wild vines. Hundreds exist, but only a few varieties are used commercially in California.

Rupestris St. George is the standard phylloxera-resistant stock for wine-grape varieties on the nonirrigated soils in the coastal valleys of California. Under these conditions it is recommended, and used almost to the exclusion of all others. It is vigorous, roots well from cuttings, grafts well, and is highly resistant to phylloxera and to drought. Its chief faults are its profuse suckering, if the disbudding before planting is neglected or poorly done, and the tendency of the scion varieties on it to produce straggly clusters and shot berries under some conditions. It is not resistant to nematodes.

Aramon × Rupestris No. 1 usually surpasses St. George in growth and productivity in irrigated soils that are free from nematodes. It is less resistant to phylloxera than St. George and is even more susceptible to nematodes than most of the fruiting varieties. In experimental test plots on irrigated, nematode-free soil the vines have been the largest, most vigorous produced on any stock and, when properly pruned, have borne enormous crops. This stock appears to be the best one commercially available for wine-grape varieties in irrigated loam soils of the great central valley of California. It also does well in deep, moist soils in the coastal valleys, but it is not recommended for dry hillside land anywhere. In the sandy, nematode-infested soils found in parts of the San Joaquin Valley it is practically worthless.

Solonis × Othello 1613 is highly resistant to the root-knot nematode and moderately resistant to phylloxera. In fertile, irrigated, sandy-loam soils in the San Joaquin Valley it is usually the best rootstock available. It grafts readily to nearly all varieties; the vines are moderately vigorous, produce well in suitable soil, and yield good table grapes of most varieties. Its congeniality with Ribier is questionable, but no other variety is known to be incompatible with it. In nonirrigated soils and in very poor sandy soils the vines are apt to be weak and unproductive. In loam and heavier soils, whether irrigated or not, the Aramon × Rupestris No. 1 stock produces more vigorous and more productive vines than the 1613; but the quality of table grapes is often better on the 1613.

Dogridge and Salt Creek are extremely vigorous nematode-resistant root-

[5] These methods are described in: Jacob, H. E. Grape growing in California. California Agr. Ext. Cir. 116:1–80. 1940.

stock varieties. Both are still in the experimental testing stage and are recommended for trial only in very sandy soil of low fertility where vines on 1613 are too weak to be satisfactory. In fertile sandy or sandy-loam soils the vines often grow with such extreme vigor that they are unproductive. They are available only in limited quantity.

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